Space Weather Technical Forecast

Issued on Friday, 10 November 2023 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Active fluence (1e8 integrated pfu) expected. Chance of isolated M-class flares. Chance of a G3/Strong geomagnetic storm late tomorrow or early day 3 (12th).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Low with only C-class flares observed in the last 24 hours, the largest a C2 at 09/1118 UTC in the vicinity of AR3480 There are currently seven regions on the visible disc.
The largest region on the disc remains AR3477(Eko/Beta-gamma) in the southwest, and is one of two moderately magnetically complex regions, and appears stable. The other region, AR3483 (Eai/beta-gamma) has produced the majority of the low level C-class flares. The remaining regions are apparently small, weak, magnetically simple and stable or declining. However, the C2 flare appears to have originated in the vicinity of AR3480, which is currently classified at Cro/beta.
A dimming event just west of the centre disc occurred around the time of the C2 flare and generated a large CME, which has been modelled to be Earth directed and forecast to arrive at Earth tomorrow (11th) .

Solar Wind / Geomagnetic Activity: Solar winds at L1, as observed by DSCOVR, showed the continued enhancement from a high speed stream associated with CH67/- with average wind speeds most likely at slightly elevated levels around 450-480 m/s. However, temporary fluctuations were observed in the DSCOVR data, indicating brief periods of strong wind speeds over 600 km/s. These fluctuations are considered to be unreliable. The total interplanetary magnetic field strength (Bt) has been weak and consistently between 3-5nT. The north-south component (Bz) varied weakly, and was often negative, between -4 and +4 nT. Phi angle has been predominantly negative (towards the Sun), with just a few brief variations. Geomagnetic activity has been Quiet to Unsettled (Kp 2-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux started at background levels, but then increased to moderate levels later in the 24 hour period, ending at 2.73 pfu, probably in response to the C2 flare and associated CME. GOES16 high energy (greater than 2MeV) electron flux was at moderate levels initially, but then after 09/1125 UTC was predominantly at high levels, peaking at 2555 pfu at 09/1510UTC. The associated 24-hour fluence gradually increased through the day, although remained just below the Active threshold (1e8 integrated pfu). The fluence observation at 10/0000 UTC was 9.916e7 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low solar activity is expected through the period, but with a chance of isolated M-class flares. Returning or new regions are likely to rotate onto the visible disc through the period, starting tomorrow, and so the chance of significant flares may increase over the coming days.

Solar Wind / Geomagnetic Activity: Confidence is high that an Earth-directed will arrive during the forecast period, generating G1-G2/Minor to Moderate geomagnetic storms, with a chance of G3/Strong geomagnetic storms. Confidence is lower regarding the arrival time, but currently the CME is expected to arrive tomorrow (11th) afternoon. Before the arrival of the CME Quiet to Unsettled (Kp 2-3) geomagnetic activity is expected, but with a chance of isolated Active (Kp 4) intervals today, due to residual high speed stream influence from CH67. Following the CME arrival geomagnetic activity is expected to gradually decline to Quiet to Unsettled (Kp 2-3) levels by the end of the period.

Energetic Particles / Solar Radiation: There is a slight chance that the high energy (greater than 10MeV) proton flux reaches S1 levels, due to the locations of the regions on the disc that are most likely to produce significant flares, and also because of the current slight enhancement in the high energy proton flux.
High energy electron flux (greater than 2MeV) is expected to remain predominantly at High levels until the arrival of the expected CME tomorrow, then rapidly falling to background or moderate levels. As the expected geomagnetic enhancement subsides later in the forecast period so the high energy electron flux levels are expected to increase again, reaching High levels again during days 3 and 4 (12th and 13th). The associated 24-hour electron fluence is expected to exceed the Active (1e8 integrated pfu) threshold today and tomorrow, dropping below after the CME arrives, and then possibly reaching Active levels again during day 4.

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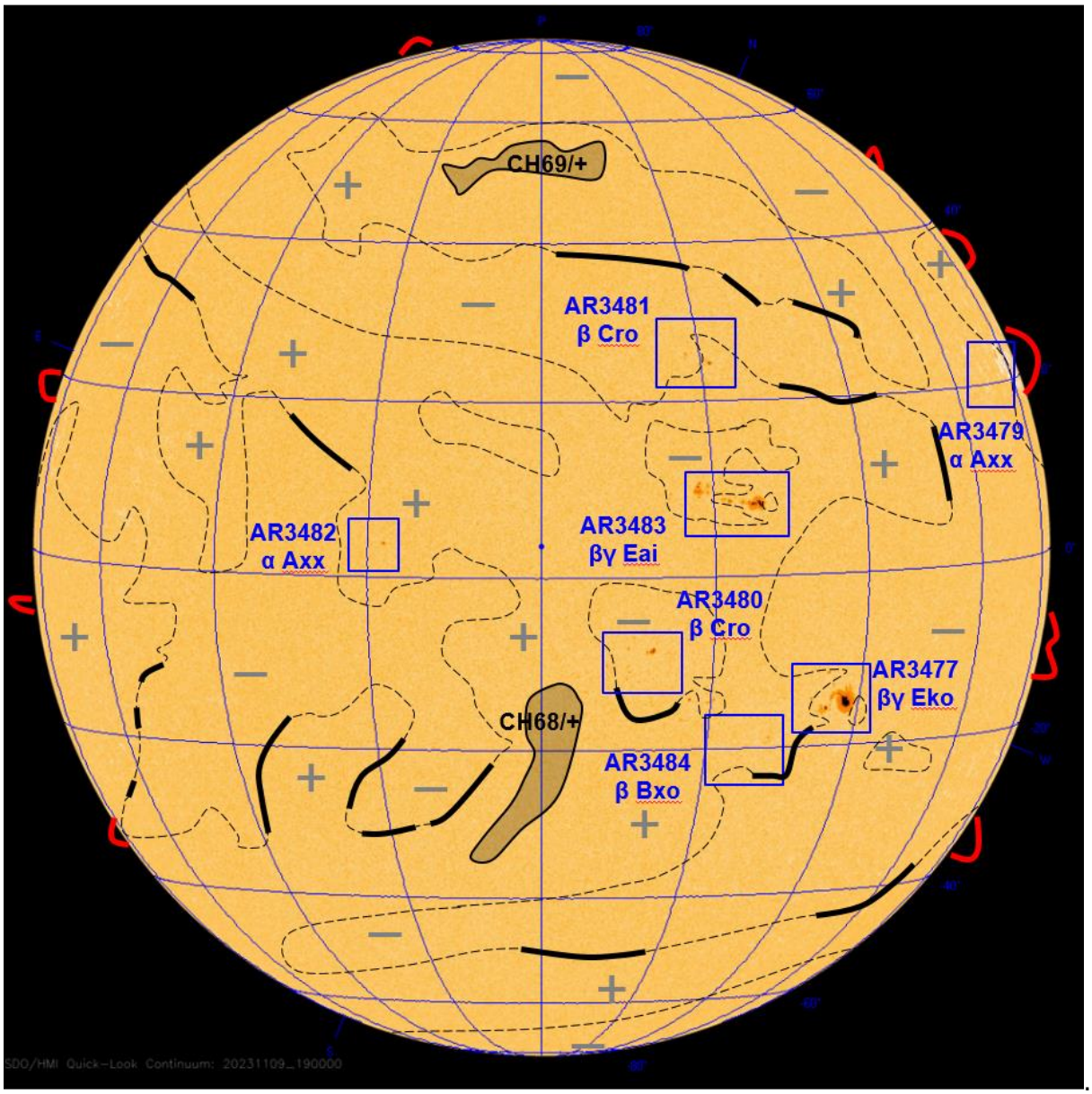
Figure 1. Solar Analysis Valid 09/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

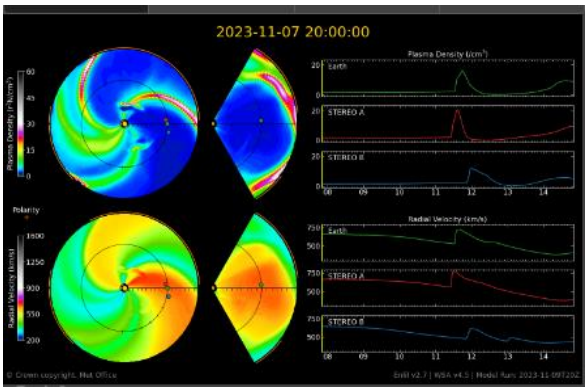
Confidence is high that an Earth-directed will arrive during the forecast period, as a full halo CME was observed in imagery following the C2 flare on the 9th and associated coronal dimming. This CME is expected to generate G1-G2/Minor to Moderate geomagnetic storms, with a chance of G3/Strong geomagnetic storms. Confidence is lower regarding the arrival time, but currently the CME is expected to arrive around 1400 UTC on the 11th, plus or minus 6 hours. Before the arrival of the CME Quiet to Unsettled (Kp 2-3) geomagnetic activity is expected, but with a chance of isolated Active (Kp 4) intervals today, due to residual high speed stream influence from CH67. Following the CME arrival geomagnetic activity is expected to gradually decline to Quiet to Unsettled (Kp 2-3) levels by the end of the period

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	90	80	30
Strong	G3	No	1	40	20	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/1512	Full	Near SR3480. Possible filament eruption	SW	936	11/1400 UTC	High confidence for CME arrival, but lower for time.

Figure 2: MOSWOC Enlil



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Radio Blackouts - X-Ray Flares:

There are currently seven regions on the visible disc. AR3477 (Eko/Beta-Gamma) in the southwest remains by far the largest group, comprising of one large and mature spot and a few small spots in the lead portion. The trailing portion is barley visible, having faded to pores. This group has been largely stable, as a result, the associated flare values for AR3477 may be misleading. The most complex region is AR3483 (Eai/Beta-Gamma), near centre disc. AR3483 continues to increase, with a recent slight enlargement of the penumbra around some intermediate spots. AR3480 has recently been reclassified Cro/Beta after the weak spots faded in its trailing portion, but despite its simple classification the largest flare of the past 24 hours appeared to occur close to AR3480. The remaining regions are apparently small, weak, magnetically simple and stable or declining
Generally Low activity is anticipated, but with an ongoing chance of isolated M-Class flares, most likely from emanating from AR3477, AR3480 and AR3483. STEREO-Ahead EUVI imagery and seismic signatures suggest that new or returning regions could rotate onto the visible disc through the period, starting tomorrow, and so the chance of significant flares may increase over the coming days.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at moderate levels, most likely in response to the long duration C2 flare which peaked at 09/1118 UTC. The current enhancement is likely to continue through today, leading to a chance of a S1 event occurring today. This chance continues for the rest of the period as the regions most likely to produce significant flares (AR3477, AR3480 and AR3483) continue, or transit to, favourable geo-effective longitudes.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	20	20	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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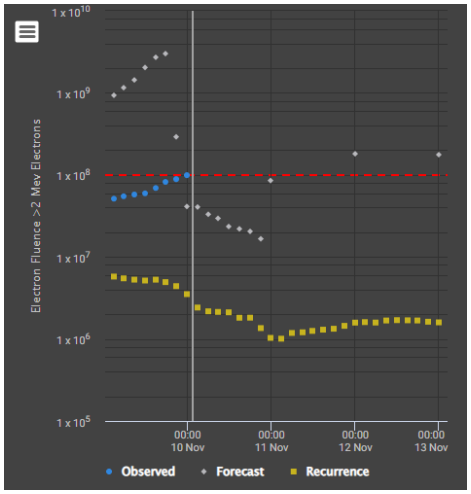
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to remain predominantly at High levels until the arrival of the expected CME tomorrow, then rapidly falling to background or moderate levels. As the expected geomagnetic enhancement subsides later in the forecast period so the high energy electron flux levels are expected to increase again, reaching High levels again during days 3 and 4 (12th and 13th). The associated 24-hour electron fluence is expected to exceed the Active (1e8 integrated pfu) threshold today and tomorrow, dropping below after the CME arrives, and then possibly reaching Active levels again during day 4 as the high energy electron flux rapidly recovers.

The overall trend of the MOSWOC REFM model is currently underestimating the fluence, and is showing a decreasing trend through today, with a rising trend thereafter. This s considered to be offering poor guidance, with an increasing trend forecast through today and with Active threshold expected to be breached.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	90	90	30	60
Very Active	≥ 2 MeV ≥ $1x10^9$	No	10	10	2	1

Figure 3: MOSWOC REFM model



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